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ABSTRACT

The research presented in this paper is part of a larger study that focused on increasing elementary school girls' attitudes toward and achievement in science and mathematics. Teachers from inner-city Philadelphia (n=21) participated in the Sisters in Science Program during the 1997-98 school year. This report presents teachers' reflections and dialogue concerning the conceptions they held of teaching science and mathematics as they confronted the issue of equitable practice while participating in Sisters in Science. Contains 59 references. (WRM)

The Sisters in Science Program:

Teachers Reflective Dialogue on Confronting the Gender Gap

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Running Head: SISTERS IN SCIENCE

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The Sisters in Science Program:

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Temple University's College of Education and Center for Intergenerational Learning developed the *Sisters in Science* (SIS) program, a program sponsored by the National Science Foundation (HRD 9553426). *Sisters in Science* was conceived in the context of broadening the concept of teaching and learning for all students by uniting the active participation of parents and intergenerational role models with other factors that promote females' success in science. Inherent in the program goals is the notion of confronting the gender gap. *Sisters in Science* has chosen to do this in part by familiarizing teachers with reform initiatives in science education, focusing particularly on their role as change agents in the reforming of gender equity in the classroom.

Current science education reforms have focused on changing the curriculum, teaching and assessment in K-12 education to make it more equitable (National Research Council (NRC), 1996; Rutherford and Ahlgren, 1990). Specifically, the National Science Education Standards emphasize the "development of environments that enable students to learn science that provide equitable opportunities for all students to learn science" (NRC, 1996 pp. 4,7). However, recent studies on equitable practices in the classroom tell a different story of the current educational climate (Eder, Evans & Parker, 1995; Orensteing, 1994; Pipher, 1994). While much of the science education reform literature acknowledges the central importance of "equity issues", the discussion centers around a "color-blind" point of view (Cochron-Smith, 1995; Ladson-Billings, 1995; Rodriques, 1997) rather than acknowledging differences in students. The Association for Educators of Teachers in Science indicate in their Professional Knowledge Standards that "unless prospective and practicing teachers can develop the knowledge, skills and beliefs called for in the reform

documents little will change" (AETS, 1996). While the standards address the issue of equitable practice in the classroom they fail to capitalize on the importance of preparing teachers to issues of equity in the classroom. Methods for equitable practice must be embedded into the reform initiatives to ensure that all students are given the best possible chance for success.

Sisters in Science is a reform driven initiative. Monies for programs like *Sisters in Science* have come into existence via the passage of legislation. Such government actions include Title IX of the Education Amendments Act. Passed in 1972, Title IX was enacted to address the inequities in educational programs receiving federal dollars. In 1974, the Women's Educational Equity Act was passed. It expanded math, science, and technology programs for females. In 1994, a package of gender-equity provisions was included in the Elementary and Secondary Education Act. Among the provisions was the creation of teacher training activities that work to eliminate inequitable practices and to develop programs to increase girl's participation in math and science (Parkay & Hardcastle-Stanford, 1998).While legal barriers to achieving gender equity have been removed, there are often barriers educators still face. These are barriers of the mind (Malcom, 1997).

Barriers in Their Minds

Shirley M. Malcolm, of the American Association for the Advancement of Science (AAAS), said in her keynote address at the American Association of University Women (AAUW) conference "Girls Succeeding in Science, Math, and Technology: Who Works and What Works,"

> "The effort to equalize educational opportunities for girls is far from complete." She notes, "Unlike some other nations, female students in the United States are legally guaranteed access to math and science courses. While our legal barriers to this education have been removed, there are often still barriers we face, these are 'barriers of the mind."(Malcolm, speech AAUW, 1997)

Many barriers still exist that prevent females from participating fully in science and mathematics throughout their lives. The organizational characteristics of science and

mathematics play important roles in diminishing the achievement of females in science and mathematics (Bleier, 1984; Harding, 1986; Kahle and Meece, 1984; Keller, 1985, 1986, AAUW, 1990). Other researchers agree that females' perceptions about science and mathematics act as barriers to females' expressing interest in science and mathematics in school (Baker & Leary, 1995; Kelly, 1985; Shroyer, Powell, & Backe, 1991). Also, the perception that science and mathematics are masculine domains discourages females' from choosing science and mathematics related careers (Kelly, 1985).

In addition to females' perceptions about science and mathematics, researchers have found that while both boys and girls enjoy math and science in elementary school, girls' interest and confidence in their abilities to excel in those areas declines sharply during adolescence. The AAUW's 1992 survey "Shortchanging Girls, Shortchanging America" reported that the percentage of girls who said they enjoyed math dropped from 81% in elementary school to 61% in high school. This is particularly true among females from economically and educationally disadvantaged families who have limited access to educational resources and are often forced to cope with stressful life experiences (Kueftle, Rakow, & Welch, 1983; Mullis & Jenkins, 1988' Schibeci & Riley, 1986; Simpson & Oliver, 1990; Vetter & Babco, 1989; Ware & Lee, 1988).

The 1992 AAUW report found that girls were frequently discouraged from exploring fields such as math, science, and technology, often unintentionally, by parents and teachers who steered them toward traditional female occupations. For example, the National Science Foundation reported that women made up about half of those working in the social sciences, but accounted for only 8 % of the nation's engineers. The AAUW's report also uncovered a strong link between females students' confidence in their mathematics and science abilities and overall self-esteem.

The study noted, "As girls learn, they are not good at these subjects, their sense of self-worth and aspirations for themselves deteriorates." Similarly, the AAUW research found that both girls and boys "who like math and science have higher self-esteem, greater

career aspirations, and are more likely to hold onto their dreams. Therefore, it is imperative to continue to instill positive accessible images about science and mathematics in the minds of girls. Positive perceptions will in turn lead to greater female participation in science and mathematics with respect to academic endeavors and career aspirations.

Barriers In The Classroom

Another line of research on gender inequity in science and mathematics focuses on the classroom environment. One cause of disparities in the classroom is that teachers' beliefs about students' abilities affect the manner in which female students operate in the classroom (Shepardson & Pizzini, 1992). Teachers by nature through years of practice based on observations of teaching, society, and schooling often have inherent ideas that include stereotypical attitudes towards gender roles which can exacerbate their use of inequitable teaching practices (Bailey, Scantlebury, Johnson, 1997). A study by Scantlebury and Kahle (1993) concluded that preservice teachers need specific training in equitable teaching strategies. This also can be said for teachers just learning about equitable practice. If teachers are provided guidance and strategies to impart gender equitable instruction they may continue to use these practices. Science teachers have proven to be more open to change when convinced that inequitable interactions tended to occur in their own classrooms (Scantlebury & Kahle, 1993), given the opportunity to reflect on the data, and suggest modifications in the classroom learning environment.

Studies also suggest that within classrooms, males and females receive a very different education (Jones & Wheatley, 1990). Girls have less exposure to science equipment than do boys. Girls also become less active in science classes as they progress through the grade levels (Klein, 1991). Female students also tend to differ from their male cohorts in their receptivity to and participation in science education. It has been noted that female students contribute less often to classroom discussion than their male classmates do. In fact, girls conversations and the matters with which they concern themselves (i. e., interactional issues) are different from those of boys (Theberg, 1993). Finally, currently

implemented science education, which is often competitive and individualistic, runs counter to female learning styles that are more cooperative and interdependent in nature. Shakeshaft (1995) says that science education classes have expectations that simply exclude girls leading to lower participation and achievement.

A girl's perception of science also contributes to inequity in achievement. It has been found that female students harbor stereotypical ideas about science and scientists. They often feel that science is a male dominated field (Hammrich, 1996). A meta-analysis (Weinburgh, 1993) of the literature on gender differences in students' attitudes toward science found a correlation between students' attitudes about science and their achievements in science. Weinburgh concluded that boys are more positive about science. Also, positive attitudes about science result in high achievement (Weinburgh, 1995).

Reformists believe that there are some essentials to encouraging female student success in the classroom. They include fostering a safe and nurturing environment, promoting problem-solving skills, creating collaborative experiences, using hands-on learning and allowing for open discussion about gender stereotypes (Allen, 1995; Mann, 1994).

Boland (1995) offers a set of strategies to promote gender equity in science and mathematics classrooms, shown in the following abbreviated list:

- ß Explore career options
- ß Utilize cooperative learning strategies
- ß Accept more than one right answer,
- ß Create equitable turn taking and use peer tutoring.
- ß Link math with careers in science,
- ß Display images of males and females in career roles.
- ß Vary teaching techniques.
- ß Assign tasks equally,
- ß Monitor groups for equity,
- ß Encourage problem solving
- ß Tap students learning styles,

In order to create gender-sensitive learning its necessary for educators to deal with issues pertaining to girls and their education rather than merely equalizing the treatment of males and females (Martin, 1996). Several strategies have been offered by Martin to ensure a gender-sensitive classroom. The first is to utilize female-appropriate teaching and learning strategies and approaches to science. The second is to address the needs and experiences of girls. The third is to emphasize the importance of the social dynamic in the construction of the classroom environment. The fourth is to acknowledge the contributions and barriers of women in science. The fifth is to incorporate the impact of private and personal aspects of girls' lives on their educational experiences. The sixth is to remove the barriers that prevent girls from pursuing careers in science (Martin, 1996).

Experiences Outside Of The Classroom

Declining interest in science and mathematics among females is additionally affected by experiences outside of school. It seems logical to expect that females' positive attitudes toward science are fostered by instructional methods, role models, and peer and social factors inside and outside of the school. Research has documented that these factors play a significant role in promoting success in science for females (Bleier, 1984; Harding, 1986; Kahle and Meece, 1994; Keller, 1985, 1986). Many females receive little or no reinforcement of their initial interest in science and mathematics from their families or social environment (AAUW, 1992). Research has reported that females and males have vastly different science and mathematics related experiences inside and outside the school (Kahle & Lakes; 1983; Linn, 1990; Rosser, 1990; Sjoberg & Imsen, 1988). Indirect and direct experiences that contribute to such difference include playing with scientific games and toys (Casserly, 1980; Hilton & Berglund, 1974), participating in science and mathematics activities at home (Kahle and Lakes, 1983; Mullis and Jenkins, 1988), taking science related field trips (Kahle and Lakes, 1983, parental stereotypic behavioral expectations (Hoffman, 1977; Morgan, 1992), expectations for independence (Block, 1978; Hoffman,

1972), and parents' educational and vocational aspirations (Adelman, 1991; Brody and Fox, 1980).

Some females succeed academically in science despite the adverse circumstances (Bailey, 1996). Research has shown that when male and female high school seniors take the same amount and kind of science courses, females tend to outperform males (Adelman, 1991; Kahle and Meece, 1994; Mulls and Jenkins, 1988). Research suggests that it is not that females cannot and do not have the ability to succeed in science, but rather that obstacles arise in recruiting and retaining females in the science workforce (Kahle and Meece, 1994).

Pedagogical Focus

The female-friendly instructional strategies, spoken about in Martin (1996), are essential to science learning for girls. Constructivism, an epistemological perspective of knowledge acquisition, serves as the foundation for many of the aforementioned suggestions regarding science and mathematics education reform. By definition, of which there are many, constructivism is an approach to teaching. Constructivists believe that children learn by doing. Learning involves changing pre-existing schema using new information acquired through varied experiences (Damon et. al., 1997). In the constructivist framework, learning is both social and dialogical in nature. That is, as human beings interact with objects in their surroundings they construct mental models of their environment. The constant interaction of human and environment creates learning about the world (Driver, 1995). In short, people learn in partnership with other individuals and learn that knowledge is socially agreed upon.

What then do science and mathematics educators need to do in order to foster science learning from a constructivist perspective? Reformists believe there are some essentials to encouraging female student success in the classroom. They include fostering a safe and nurturing environment, promoting problem solving skills, creating collaborative

experiences, using hands-on learning and allowing for open discussion about gender stereotypes (Allen, 1995 & Mann, 1994).

Driver (1995) also offers some suggestions to science and mathematics education. She suggests that learners need to be given access to physical experiences as well as concepts and models of conventional science and mathematics. Science and mathematics learning should account for what the learner brings to the learning situation, as well as their purposes and ideas, which can differ for each socially constructed group, particularly, females. Finally, teachers need to be the presenter of experiences that enable students to make mental connections to pre-existing events.

In addition, the "Science for All Americans" (AAAS, 1985) report extends Driver's list by suggesting that students should have opportunities to: express themselves in oral and written form, work in teams, solve problems, question, explore and discover concepts, use authentic tools, and learn about related professions and professional contributions to the field.

The *Sisters in Science* program offers a multilevel intervention centered on gender sensitive instruction and a constructivist learning model. To this end, cooperative exploratory hands-on science and mathematics education tasks along with self-reflection are employed to facilitate female friendly learning environment. Within this framework of constructivist learning, the *Sisters in Science* program was designed to provide instructional methods that demasculize and demystify science and mathematics, promote women role models and career information, and allow for active involvement. While girls are "doing" science and mathematics their self-confidence and self-perceptions of their ability to do science and mathematics is enhanced (Hammrich, 1997).

Teacher Program

One of the foci of *Sisters in Science* was on the role of teachers as decision makers in promoting scientific literacy for all students. The overall goal was to familiarize teachers with reform initiatives in science education and to chart their progress as change agents of

gender equity in the classroom. The goal was addressed through a two week summer institute and year long academic curriculum meetings. The focus of the summer institute was for teachers to become familiar with and competent in the areas of equitable strategies in science and mathematics education, strategies for constructivist teaching, strategies on integrating mathematics and science, and evaluation and assessment practices within the context of the SIS program. At the end of the two week summer institute teachers along with the science educators developed activities and guidelines to follow in the classroom in the current year. During the academic curriculum meetings teachers participated in focus group reflection and dialogue.

In their respective classrooms the role of the teachers was multifaceted. Not only did they teach integrated science/mathematics lessons that were constructivist in nature and embedded in gender equitable practice but once a week for 2 hours they supervised methods student's teaching in the in-school part of the program. The teachers observed the methods student's teaching and made observation notes as to the nature of their science/mathematics lesson as far as it was an integrated science/mathematics lesson that was constructivist and embedded in equitable practice.

Purpose

The research presented here is part of a larger research program that focused on increasing the science/mathematics attitudes and achievement of elementary school girls. Twenty one teachers from seven different schools located in Philadelphia's inner city participated in the *Sisters in Science Program* during the 1997-1998 academic year. This paper reports on teachers' reflection and dialogue concerning their conception changes of teaching science and mathematics as they confront the issue of equitable practice while participating in *Sisters in Science.*

Procedure

Design

Data collection consisted of notes, videotaped sessions, questionnaires, subsequent focus groups and a collection of demographic information. The semi-structured and open-ended focus group questions were designed to elucidate teachers' conceptions of science/mathematics and their perceptions of confronting the gender gap. Teachers completed 2 two hour focus group sessions which were videotaped and transcribed. The first focus group was conducted mid year and the second focus group was conducted at the end of the school year. Data was also collected separately in a survey, concerning how the teachers now teach science and mathematics, and what changes, if any, they have made.

Analysis and Interpretation

Grounded theory was the method of analysis for this study (Strauss, 1987). Focus group responses were videotaped, transcribed and coded in a data file using Ethnograph v4.0. Cases were examined as a whole. Extensive memoing and preliminary assertions were logged as focus group responses were conducted, transcribed, read, and re-read to find words, phrases and themes that reflected teachers conceptions concerning science/mathematics teaching and perceptions of confronting the gender gap. The focus group responses were analyzed using Patton's (1990) method for generating themes. Through the constant comparative method (Strauss, 1987) themes emerged and assertions developed. From these preliminary assertions were made and data was highlighted as to possible warrants to support these assertions. Coding of data included both inter-rater and intra-rater reliability as well as several other provisions for trustworthiness.

Outcomes

Results from the questionnaires and focus groups show that there has been a real change on the part of the teachers. Specifically, the teacher report that , as a result of the cooperation between the schools and the university, they are now teaching science and mathematics more effectively: (1) they are increasing the amount of time in which science

and mathematics are taught in their classrooms, (2) they are promoting connections within science, within mathematics, and between science and mathematics, (3) they are adopting more gender equitable constructivist approach to teaching both science and mathematics, and (4) they are changing their own attitudes about science and mathematics in a positive direction.

In response to the focus group reflective dialogue sessions two assertions emerged that characterized the teachers as a whole.

Discussion of Assertions

Assertion #1: Although the teachers participating in the focus groups had varying conceptions of science/mathematics teaching their comments revealed that they are now teaching more science/mathematics and are enjoying these subject areas more. However, even through the teachers were accepting of examining and even embracing new conceptions of science/mathematics teaching, they clung to their prior conception of science/mathematics teaching when pressed with uncertainty in a teaching situation.

Assertion #2: Teachers indicated that although they recognize the necessity of addressing equitable teaching strategies they are not always conscious of practices that exclude girls in the learning process. As a result of participating in the program they expressed that they are using more equitable approaches towards instruction and are more reflective of their own teaching practices

By the time teachers enter the teaching field they have already developed a conception of teaching and learning (Perry, 1990). Quite often they have not reflected on their conception of science and delivery of equitable instruction and how their conceptions influences their conception of effective equitable science instruction. As this study shows while teachers are accepting of examining and even embracing new conceptions of science teaching, they still cling to their prior conception of science teaching when pressed with uncertainty in a teaching situation. This maybe due to lack of practical experience, reflection, or lack of specific knowledge.

In all the classrooms observed, students were engaged in activities - which is expected since the observations were planned in consultation with teachers. Students were seen working in small groups and the teacher moved from group to group asking questions. Teachers were seen equally engaging boys and girls in dialogue and in

interactions. The teachers were also seen incorporating the conceptual change equitable pedagogy in their instruction.

In all likelihood, the teachers were presenting what they considered good examples of constructivist equitable instruction. The smoothness with which the lessons went was suggestive of regular practice. It appeared that the students were used to doing activities. All science teachers know that if students are not used to working in groups and doing hands on activities, classroom interactions become chaotic, students seem to be confused and tend to have a lack of basic procedural questions both for each other and the teachers. Any experienced observer can tell whether students in a classroom are used to doing activities or if they are participating in an unusual lesson. When activities are frequent, students get used to basic protocols, they might have specific questions pertaining to certain activities, overall classroom interactions flow smoothly. At the beginning of the year, such a flow was absent in many of the teachers classrooms indicating activities were infrequent; however, towards the middle of the year most of the teachers classrooms seem to be flowing smoothly.

Teachers seemed to focus more on concepts and less on vocabulary. Many of the teachers were incorporating alternative assessment measures such as portfolios, performance assessment, journals, and projects. In addition to these, a common instructional feature observed in each classroom was the informal assessment (Haertel, 1991) practiced by the teachers while students were engaged in small group activities. It was also noticed that both the girls and boys interacted actively in the small groups and in answering and asking questions. One area that became noticeable throughout the year that it was easy to identify the girls that were taking part in the SIS after school program. These girls seem to have a presence in the group activities. They were seen being the leaders of the group and very sure of their answers to questions. All in all these girls were seen as very dominate in the classroom.

One area that was observed to be weak in promoting equity was in the classroom atmosphere. Most teachers did not have images of scientists on their wall nor did they make reference to science careers (see table 1).

Table 1. Classroom Teacher Observation Checklist Spring 1998
N=16

Item	Frequency	Percentage
Interactions		
1. Teacher equally engages boys and girls in dialogue.	16	100%
2. Teacher interacts equally with boys and girls.	16	100%
3. Teacher equally encourages boys and girls to accept the same roles in the classroom	15	94%
4. Teacher listens to boys and girls equally.	16	100%
5. Teacher equally acknowledges boys and girls' responses/explanations.	16	100%
6. Students work in a cooperative manner.	12	75%
7. Boys and girls do similar tasks in the classroom.	16	100%
Average	15.3	96%
Conceptual Change-Pedagogy		
1. Teacher equally engages boys and girls in higher order thinking.	15	94%
2. Teacher assesses prior knowledge.	15	94%
3. Teacher confronts misconceptions.	14	88%
4. Teacher corrects misconceptions.	14	88%
5. Teacher accepts more than one right answer.	15	94%
6. Teacher equally asks open-ended questions of boys and girls.	15	94%
7. Teacher equally encourages boys and girls to initiate questioning.	5	31%
Average	13.3	83%
Atmosphere		
1. Diverse images of scientist/science careers are present (gender, race/ethnicity, age).	2	13%
2. Teacher makes references to science and careers in science.	5	31%
3. Teacher connects classroom activities to real life experiences for students.	13	81%
Average	6.7	42%
Activity Type		
1. Activities are hands-on.	12	75%
2. All students use authentic tools and manipulatives to solve problems.	12	75%
3. Activities are cooperative in nature.	12	75%
4. Activities integrate math and science skills.	9	56%
5. Teacher accepts a variety of student performance outcomes.	11	36%
6. Teacher allows for student exploration.	13	81%
7. Teacher allows for student lead instruction.	4	25%
8. Activities are structured.	15	94%
Average	11	36%

Research suggests that teachers' beliefs and reflections are important drivers of classroom actions and thus need to be considered in understanding changes in practice or any lack thereof (Peterson, Fennema, Carpenter & Loef, 1989; Schon, 1991). Beliefs act as the theories that guide actions and reflections and dialogue allow an examination of those actions in terms of one's beliefs and promote necessary modifications in either actions or beliefs.

Reflection and dialoguing on their practice in the classroom, teachers expressed that they are more aware of what they need to do in the classroom to promote equitable practice that is constructivist. All of the teachers expressed that they were not always conscious of practices that exclude girls in the learning process but as they reflected upon their teaching they became more conscious of their practice and were able to adjust their teaching to include all students, not just the girls, in the learning process. The teachers said that being apart of the programs design and having open dialogue with one another and the SIS staff helped them in their reflection and practice. They felt less isolated and more involved in the reform process in their classroom.

> One teacher noted, "I try more hands-on activities and coordinate more with science teachers. I believe it is a part of working with SIS. It also caused me to go to more outside activities. I realized that when I show interest the children show interest"
>
> Another teacher noted, "I wouldn't dare to not have a hands-on science activity. Children would not accept worksheets"
>
> Many teachers stated, "We have become more reflective of our own teaching"

Many of the teachers say they enjoy teaching science more. A number of teachers expressed that they have developed new ways of teaching science and mathematics throughout the year. All of the teachers expressed the belief that involving all students in the learning process was crucial for effective teaching. The teachers noticed that their

students became more excited about learning when they were actively engaged in activities. They also noted that the girls seemed to blossom in the classroom when they were working on projects or in groups. Teachers also confirmed in their reflection that the girls who were in the SIS afterschool program were much more engaged in the activities that the other girls in the classroom. They reported that these girls tended to identify as *"Sisters in Science"* - meaning that they felt like this was their program and in a sense it gave these girls some power and voice.

> One teacher noted, "The 'Sisters in Science' girls were more eager to participate"
>
> Another teacher noted, "The girls were quite assertive.. out of their seats"
>
> Another teacher noted, "I saw the girls becoming more involved in science activities as time went on"
>
> Another teacher noted, "The girls in the 'Sisters in Science' program show more confidence"
>
> Another teacher noted, "That the girls say they have fun learning science"

Teachers agree that they have become more reflective of their teaching experience. However, the teachers did expressed the concern that when they are confronted with teaching a science topic that is new and unfamiliar they tended to revert back to a more traditional teaching approach. They also noticed that when this occurred the girls become less participatory in the activities. Specifically related to equitable practice, teachers revealed that not all their lessons make a connection to gender sensitivity but they are still learning and trying new approaches. This was a concern expressed by all the teachers. However, they said that by just being conscious of this occurrence was helping them change their teaching practice. They tend to be able to be mindful of what is occurring and try to change their practice.

> One teacher noted, "I became more conscious of who I was calling on"

Another teacher noted, "I believe I was more equitable"

In summary, while many of the teachers expressed their conception of science teaching that promotes equity as a practice they are taking, they readily fell back on the conception of science teaching when they were teaching something new. Basically, teachers were more readily accepting of the notion of the equitable science instruction when they were familiar with the science topic.

Conclusion

The call for systemic reform presents a great challenge in facilitating teachers' conceptions of science/mathematics teaching and practices of confronting the gender gap. In order for teachers to model practices of teaching that promote gender equity in science and mathematics, they must participate in reflective practice. Teachers must be actively involved in the process of reform because they are the change agents of reform in the classrooms. Reforming science/mathematics teaching that confront the gender gap requires reforming teachers conceptions first. Unless teachers reflect upon and practice reformed teaching strategies that promote gender equity, it is unrealistic to expect change.

As schools strive to embed equitable practice into their curriculum they must actively involve teachers in the process of reform. The implementation of new teaching approaches that involve equity has to have a reciprocal relationship with teachers conceptions and actions, because teachers are the agents of reform in the classrooms. How reform in the practice of promoting equity in science education should be implemented into a classroom must be informed by teachers conceptions of science teaching and equitable practice. Likewise, teachers need to be informed by the research on equitable practice.

References

Adelman, C. (1991). Women at thirtysomething: Paradoxes of attainment. Washington, DC: Office of Educational Research and Improvement, U.S. Department of Education.

Allen, D. (1995). Encouraging success in female students: Helping girls develop mathematics and science skills. Gifted Child Today Magazine, 18(2), 44-45.

American Association for the Advancement of Science. (1985). Science for All Americans. Washington, DC: American Association for the Advancement of Science.

American Association of University Women. (1990). Agenda for action (Publication No. 90-13S). Washington, DC: Author.

American Association of University Women. (1992). How school shortchange girls. Washington, DC: Author.

Association for Educators of Teachers in Science. (1996). Professional Knowledge Standards for Science Teacher Educators, Position Statement, AETS.

Bailey, B., Scantlebury, K., Johnson, E. (1997). Preservice science teacher education, the national standards & equity: Collaboration is the key. Presented at the Association for Educators of Teachers on Science National Conference. Cincinnati, OH

Baker, D., & Leary, R. (1995). Letting girls speak out about science. Journal of Research in Science Teaching, 32(1), 3-27.

Bleier, R. (1984). Science and gender: A critique of biology and its theories on women. New York: Pergamon.

Block, J. H. (1978). Another look at sex differentiation in the socialization behavior of mothers and fathers. In J. A. Sherman & F.L. Denmark (Eds.), Psychology of women: Future directions of research. New York: Psychological Dimensions.

Boland, P. Gender-fair math. Equity in education series. Education Development Center, Inc. Newton, MA (OERI).

Brody, L., & Fox, L.H. (1980). An accelerative intervention program for mathematically gifted girls. In L.H. Fox, L. Brody, & K. Tobin (Eds.), Women and the mathematical mystique (pp. 164-192). Baltimore: John Hopkins University Press.

Casserly, P.L. (1980). Factors affecting female participation in advanced placement programs in mathematics, chemistry, and physics. In L. H. Fox, L. Brody, & K. Tobin (Eds.), Women and the mathematical mystique. (pp. 138-163). Baltimore: John Hopkins University Press.

Cochron-Smith, M. (1995). Color blindness and basket making are not the answers: Confronting the dilemmas of race, culture, and language diversity in teacher education. American Educational Research Journal, 32(3), 493-522.

Driver, R. (1995). Constructivist approaches to science teaching. . In L. P. Steffe & J. Gale, (Eds.), Constructivism in education (pp. 385-400). Hillsdale, NJ: LEA.

Eder, D., Evans, C. & Parkder, S. (1995). Schooltalk: Gender and adolescent culture. New Brunswick, NJ: Rutgers University Press.

Haertel, E. H. (1991). Form and function in assessing science education. In G. Kulm, and S. M. Malcolm (Eds.), Science assessment in the service of reform, (pp. 233-246). Washington, DC: AAAS.

Hammrich, P. L. (1996). The resilience of girls in science. unpublished manuscript.

Hammrich. P.L. (1997). Yes, daughter, you can: Empowering parents is the first step toward improving females' achievement in science, Science and Children. 34 (4). pp. 21-24.

Harding, J. (1986). Perspectives on gender and science. Philadelphia: Falmer.

Hilton, T.L., & Berglund, G.W. (1974). Sex differences in mathematics achievement: A longitudinal study. Journal of Educational Research, 67(5), 231-237.

Hoffman, L. W. (1972). Early childhood experiences and women's achievement motives. Journal of Social Issues, 28(2), 129-155.

Hoffman, L. W. (1977). Changes in family roles, socializations, and sex differences. American Psychologist, 32(8), 644-657.

Jones, M. G. & Wheately, J. (1990). Gender differences in teacher-student interactions science classrooms. Journal of Research in Science Teaching 27(9), 861-874.

Kahle, J. B., & Lakes, M. K. (1983). The myth of equality in science classrooms. Journal of Research in Science Teaching, 20(2), 131-140.

Kahle, J.B., & Meece, J. (1994). Research on gender issues in the classroom. In A.B. Champagne (Ed.), Handbook of research on science teaching and learning. New York: MacMillan.

Kelly, A. (1985). The construction of masculine science. British Journal of Sociology of Education, 6(2), 133 - 153.

Keller, E. F. (1985). Reflections on gender and science. New Haven, CT: Yale University Press.

Keller, E. F. (1986). How gender matters: Or, why it's so hard for us to count past two. In J. Hardin (Ed.), Perspectives on gender and science (pp. 169-183). London: Falmer.

Klein, C. A. (1989). What research says about girls and science. Science and Children, 27(2), 28-31.

Kueftle, S. J., Rakow, S. J., & Welch, W. W. (1983). Images of science: A summary of results from the 1981-1982 National Assessment in Science. Minnesota Research and Evaluation Center.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. Journal of Educational Research, 32(3), 465-491.

Linn, M. C. (1990, July). Gender, mathematics and science: Trends and recommendations. Paper prepared for the Council of Chief State Officers Summer Institute, Mystic, CT.

Malcolm, S. M. (1997). Girls succedding in science, mathematics and technology: Who works and what works. American Association of University Women Conference Proceedings, 1997, Philadelphia, PA.

Mann, J. (1994). Bridging the gender gap: How girls learn. Streamlined Seminar, 13(2).

Martin, M. V. Inside a gender-sensitive classroom: An all girls physics class. Presented at the Annual Meeting of the National Association for Research in Science Teaching, April, 1, 1996, St. Louis, MO.

Morgan, C. S. (1992). College students' perceptions of barriers to women in science and engineering. Youth and Society, 24(2), 228-236.

Mullis, I.V. S., & Jenkins, L.B. (1988). The science report card: Elements of risk and recovery. Princeton, NJ: Educational Testing Service.

National Research Council (1996). National Science Education Standards. Washington, DC: National Academy Press.

Orenstein, P. (1994). Schoolgirls: young women, self-esteem, and the confidence gap. New York: Duobleday.

Parkay, F. W. & Hardcastle-Stanford, B. (1998). Becoming a teacher. 4th ed. Needham Heights, MA: Allyn & Bacon.

Perry, C.M. (1990, April). A pilot study of preservice and inservice teachers' beliefs about effective teaching. A paper presented at the annual meeting of the American Educational Research Association, Boston, MA.

Peterson, P., Fennema, E., Carpenter, T., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. Cognition and Instruction, 6(1), 1-40.

Pipher, M. (1994). Reviving Ophelia: saving the selves of adolescent girls. New York: Ballantine.

Rodriguez, A.J. (1997). The dangerous discourse of invisibility: A critique of the National Research Council's National Science Education Standards. Journal of Research in Science Teaching, 34, 19-38.

Rosser, S. V. (1990). Female friendly science. New York: Pergamon.

Shepardson, D.P., & Pizzini, E.L. (1992). Gender bias in female elementary teachers' perceptions of the science ability of students. Science Education, 76(2), 147-53.

Rutherford, F.J. & Ahlgren, A. (1990). Science for All Americans. New York, NY: Oxford University Press.

Scantlebury, K. & Kahle, J.B. (1993). The implementation of equitable teaqching strategies by high school biology student teachers. Journal of Research in Science Teaching, 30, 537-546.

Schibeci, R. A., & Riley, J. P. (1986). Influence of students' background and perceptions on science attitudes and achievement. Journal of Research in Science Teaching, 23(3). 177-187.

Schon, D.A. (1991). The reflective turn: Case studies in and on educational practice. New York: Teachers College Press.

Shepardson, D. P. & Pizzini, E. L. (1992). Gender bias in female elementary teachers' perceptions of the science ability of students. Science Education, 76(2), 147-53.

Shroyer, M. G., Powell, J. C., & Backe, K. A. (1991, April). Gender differences: What do kids tell us and what should we do in the curriculum to make a

difference? Paper presented at the annual meeting of the National Association for Research in Science Teaching, Lake Geneva, WI.

Simpson, R. D., & Oliver, J. S. (1990). A summary of major influences on attitude toward achievement in science among adolescent students. Science Education, 74, 1-18.

Sjoberg, S., & Imsen, G. (1988). Gender and science education I. In P. Fensham (Ed.), Development and dilemmas in science education (pp. 218-248). London: Falmer.

Strauss, A.L. (1987). Qualitative analysis for social scientists. New York: Cambridge University Press.

Theberg, C.L. (1993, April). The boys all scramble through: Some gender issues in science making conversations. National Science Foundation. Presented at the annual meeting of the American Educational Research Association, Atlanta, GA.

Vetter, B. M., & Babco, E. L. (1989). Professional women and minorities: A manpower data resource service. Washington, DC: Commission of Professionals in Science and Technology.

Ware, N.C., & Lee, V.E. (1988). Sex differences in choice of college science majors. American Educational Research Journal, 25, 593-614.

Weinburg, M. (1995). Gender difference in student attitude toward science: A meta-analysis of literature from 1970-1991. Journal of Research in Science Teaching, 32(4), 387-98.

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